REDUCTION OF SWITCH-ON TIME FOR ELECTRONICALLY CONTROLLED CONTACTORS

Background Information

The invention concerns switchgear, in particular relays and/or contactors with a solenoid system that includes an armature and a yoke, a coil and an open- or closed-loop controller of the switchgear drive, wherein actual values of drive-specific
5   switching parameters are measured by sensors.

Switchgear having solenoid systems, for example, contactors, are used in drive and automation technology and serve, in conjunction with other components for protecting and
10   controlling electric loads.

In order to optimize such switchgear to their switching function, taking into consideration different operating conditions and specific equipment characteristics, the principle of controlled switching drives has been developed,
15   which reduces the number of types of coils that were previously required due to their different excitation voltages. Such drives can be used for both AC and DC and, by reducing contact chatter, they reduce contact erosion and
20   extend contact life. At the same time, the power consumption of the exciter circuit during the holding phase is reduced.

Thus, European Patent Application 376 493 A1 describes a control circuit that allows for a high current during the
25   closing operation of electromagnetic valves; this current is then reduced to a relatively low holding current after the closing operation. German Offenlegungsschrift 30 47 488 A1 describes, in addition to a coil current controller, an induction controller with a Hall probe arranged in the yoke.
30   These control principles provide a higher coil current for the closing operation, which is reduced after the closing

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operation to a value that just provides for the force required for holding the armature in the closed position. German Offenlegungsschrift 44 30 867 A1 describes a switchgear drive control, which ensures that the optimum contact speeds and the

5   limitation of the armature core impact speed are observed over the entire service life, taking into consideration interfering factors such as erosion and tolerances.

While efforts have been made to achieve the aforementioned

10   object using the known circuit arrangements for switchgear drives, either complex control algorithms have had to be used or concessions concerning the requirements of high closing speed of the contact with minimized chatter and low power consumption during the holding phase of the contractor have

15   had to be made.

The object of the present invention is to provide a simple and sturdy control algorithm of the switchgear drive resulting in minimum chatter of these contacts and low power consumption of

20   the exciter circuit during the holding phase of the contactor.

This object is achieved according to the present invention by the fact that, after a switching command, the control device does not affect an output quantity, for example, coil current

25   (I), until at least a predefined threshold value of the switching parameters that are variable during a switching operation, for example, the contact speed and/or the contact path and/or the flux, is attained.

30   Thus it is achieved that the closing speed is very high, like in conventional contactor drives. After one or more limit values of specific switching parameters has been attained, such as time t or contact path s according to Claim 2, the control device intervenes via flux Φ or coil current I and

35   thus minimizes chatter. In addition, power consumption by the exciter circuit during the holding phase of the contactor is thus reduced. These threshold values can be transmitted to the

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control device via sensors. Lag elements in the control
circuit also result in delayed response of the control device.

The invention is described with reference to an embodiment.

Figure 1   shows a U core with fixed air gap, armature, coil
             and their control device;

Figure 2   shows a diagram where the magnetic flow Φ during the
             closing operation is plotted against time for
             different control principles;

Figure 3   shows a diagram where the armature path s during the
             closing operation is plotted against time t for
             different control principles.

Figure 1 shows a yoke 1 designed as a U core 3 having a fixed
air gap 2. A schematically illustrated coil 5, activated via a
control device 6, is located on each leg 4 of yoke 1. A flux
sensor 7, which transmits the instantaneous flux data to
control device 6, is arranged in fixed air gap 2.

Figure 2 shows the variation of magnetic flux Φ in fixed air
gap 2 of magnet yoke 1 over time t for different control
principles. In the case of uncontrolled variation of magnetic
flux Φ, i.e., the entire control voltage U is always applied
to coil 5, flux Φ has a variation A that is typical for the
magnetic field, causing maximum acceleration of armature 8,
which may then result in chatter on the fixed contact of the
switchgear.

Curve C shows the variation of magnetic flux Φ when control
device 6 intervenes immediately., Also in this case, the
entire voltage U is applied to coil 5 up to time t_1. As soon as
the predefined flux Φ_1 is attained, coil current I is
controlled so that this value Φ_1 of the flux is maintained
virtually constant during the remaining time of the closing

operation and during the holding phase of the contactor.

If control device 6 intervenes with a delay according to curve B, the entire control voltage U is again applied to coil 5, i.e., maximum acceleration initially occurs as in the case of unregulated contactor operation. After the elapse of a certain period of time t_2 after the switch-on command of the contactor t_0, control device 6 intervenes and, based on the value transmitted by flux sensor 7, reduces, by time t_3, coil current I and thus of flux Φ to Φ_1, which is sufficient for maintaining the contactor closed, while reducing chatter.

Figure 3 shows the variation of contact path s of a contactor over time t for different control principles, s_o being the open switch position and s_G being the closed switch position. In the case of unregulated contactor operation according to curve D, the contact closes fastest t_{IV}, since the full control voltage U is always applied to coil 5.

When the contactor drive is controlled immediately by control device 6 at time t_{II} according to curve F, the longest switch-on times t occur, since, as in the case of curve C of Figure 2, the entire control voltage U is only applied for a short period of time t_I to t_{II}.

According to curve E of Figure 3, the total switch-on time is reduced from t_{VI} to t_V, i.e., by approximately 20% to 30% when control starts with a delay at time t_{III}.

As tests have shown, the relationships can be directly applied to solenoid systems whose yoke has an E-shaped design, for example.